

Sep 14 04 02:31p

P. 2

U.S. Application Serial No. 10/725,512  
Filed with Reply to Office Action of June 17, 2004

**Attorney Docket No.: 100203000-1****PATENT****IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

Applicant: Stephen Daniel CROMWELL, et al. Examiner: H. M. HYEON  
Serial No.: 10/725,512 Art Unit: 2839  
Filed: December 3, 2003  
For: SUPPORT FOR AN INTEGRATED CIRCUIT PACKAGE HAVING A  
COLUMN GRID ARRAY INTERCONNECT

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Commissioner for Patents  
P.O. Box 1450  
Alexandria, Virginia 22313-1450

**DECLARATION OF STEPHEN DANIEL CROMWELL****PURSUANT TO 37 C.F.R. § 1.131**

Dear Sir:

1. Prior to May 22, 2003, the publication date of US Patent Application Publication No. 2003/0095392 A1, I jointly conceived of at least a supporting device for an integrated circuit package having a column grid array interconnection with a printed circuit board, comprising a shim that is inserted between the integrated circuit package and the printed circuit board, wherein said shim is mechanically and removably fastened to the printed circuit board, as claimed, in claims 1-9 of the present application.

2. Prior to May 22, 2003, I jointly conceived of at least a method for mechanically supporting an integrated circuit package having a column grid array interconnection with a printed circuit board, comprising inserting one or more supporting devices between the integrated circuit package and the printed circuit board, and mechanically and removably fastening the one or more supporting devices to the printed circuit board, as claimed. in claims 10-15 of the present application.

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Sep 14 04 02:31p

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U.S. Application Serial No. 10/725,512  
Filed with Reply to Office Action of June 17, 2004

3. On or around March 6, 2002, I jointly, with my co-inventor Xiang Dai, submitted an Invention Disclosure Form (IDF) to Hewlett-Packard's internal Legal Department (HP Legal). *See Exhibit A.* The Invention Disclosure form that I submitted included the brief description and diagrams associated with the invention. Such Invention Disclosure forms are submitted so that HP Legal can determine whether to file a patent application.

4. From immediately prior to May 22, 2003 until the December 3, 2003, the effective filing date of the present application, the claimed invention was constructively reduced to practice with due diligence.

5. On or about May 15, 2003, I discussed the IDF with Michael Ye, previously of Dorsey & Whitney LLP, in detail.

6. On or about May 22, 2003, I received a draft application describing the claimed invention from Michael Ye. *See attached print out of e-mail, Exhibit B.*

7. I subsequently reviewed the draft application and provided comments to Michael Ye.

8. On or about June 2, 2003 I received a revised draft application describing the claimed invention from Michael Ye.

9. On or about December 1, 2003, I reviewed another draft application describing the claimed invention.

10. On December 3, 2003, the present application was filed.

11. The acts related above all took place in the United States of America.

12. The declarant further states that the above statements were made with the knowledge that willful false statements and the like are punishable by fine and/or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that any such willful false statement may jeopardize the validity of this application or any patent resulting therefrom.

Date:

9/14/04



Stephen Daniel Cromwell

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U.S. Application Serial No. 10/725,512  
Filed with Reply to Office Action of June 17, 2004



**Attorney Docket No.: 100203000-1**

**PATENT**

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

Applicant: Stephen Daniel CROMWELL, et al. Examiner: H. M. HYEON  
Serial No.: 10/725,512 Art Unit: 2839  
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For: SUPPORT FOR AN INTEGRATED CIRCUIT PACKAGE HAVING A  
COLUMN GRID ARRAY INTERCONNECT

---

Commissioner for Patents  
P.O. Box 1450  
Alexandria, Virginia 22313-1450

**DECLARATION OF XIANG DIA**

**PURSUANT TO 37 C.F.R. § 1.131**

Dear Sir:

1. Prior to May 22, 2003, the publication date of US Patent Application Publication No. 2003/0095392 A1, I jointly conceived of at least a supporting device for an integrated circuit package having a column grid array interconnection with a printed circuit board, comprising a shim that is inserted between the integrated circuit package and the printed circuit board, wherein said shim is mechanically and removably fastened to the printed circuit board, as claimed, in claims 1-9 of the present application.

2. Prior to May 22, 2003, I jointly conceived of at least a method for mechanically supporting an integrated circuit package having a column grid array interconnection with a printed circuit board, comprising inserting one or more supporting devices between the integrated circuit package and the printed circuit board, and mechanically and removably fastening the one or more supporting devices to the printed circuit board, as claimed, in claims 10-15 of the present application.

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U.S. Application Serial No. 10/725,512  
Filed with Reply to Office Action of June 17, 2004

3. On or around March 6, 2002, I jointly, with my co-inventor Stephen Daniel Cromwell, submitted an Invention Disclosure Form (IDF) to Hewlett-Packard's internal Legal Department (HP Legal). *See* Exhibit A. The Invention Disclosure form that I submitted included the brief description and diagrams associated with the invention. Such Invention Disclosure forms are submitted so that HP Legal can determine whether to file a patent application.

4. From immediately prior to May 22, 2003 until the December 3, 2003, the effective filing date of the present application, the claimed invention was constructively reduced to practice with due diligence.

5. On or about June 20, 2003, I reviewed a draft application describing the claimed invention.

6. On December 3, 2003, the present application was filed.

7. The acts related above all took place in the United States of America.

8. The declarant further states that the above statements were made with the knowledge that willful false statements and the like are punishable by fine and/or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that any such willful false statement may jeopardize the validity of this application or any patent resulting therefrom.

Date: 9-16-2004



Xiang Dai

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<input type="checkbox"/> Enter PD Number
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SEP 16 2004

TRADEMARK OFFICE

## INVENTION DISCLOSURE

DATE RCVD: 03/06/2002

PDNO: 100203000

ATTORNEY: DAP

Tag Number: T0001545

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*Red text indicates a required field.*

<b>Descriptive Title of Invention:</b> Method of supporting area array solder column interconnects using corner shims between IC package and PCB	
<b>Name of Project:</b> Concorde L2 Attach Development	
<b>Product Name or Number:</b> Orca Server	
<b>Submitter Location (City):</b> Roseville California	
Was a description of the invention published, or are you planning to publish? If so, the date(s) and publication(s):	
No	Publication limited to discussion slides for internal design reviews and process assembly documentation at PRMO.
Was a product or prototype including the invention (i) announced, offered for sale, or sold to any third party (for example, customer, supplier, contract manufacturer), or (ii) sold to HP by, for example, a supplier or contract manufacturer, or (iii) is such activity proposed? If so, when and to whom?:	
No	
Was the invention disclosed to anyone outside of HP, or will such disclosure occur? If so, the date(s) and name(s):	
No	
If any of the above situations will occur within 3 months, call your IP Attorney or the Legal Department now at 898-4919 or 970-898-4919	
Was the invention described in a lab book or other record? If so, please identify (lab book #, etc.)	
Yes	2/16/01 CCGA creep issue meeting minutes; Sam's Lab book Pages 9 (date 3/14/01); 59 (date 4/9/01); Sam's email ?Concorde attach ? thermal/mechanical design opportunities to enable a reliable and manufacturable CCGA solution? 6/28/01. 07/02/01 Meeting minutes on Concorde CCGA HS attach/Solder Creep. Dan's emails ? Mechanical Attach Hardware Schedule? 5/18/01 ?Shimmed CCGA slides? 9/25/01. Also embodied in the CAD files and Design Review Slides of Dan Cromwell IASL
Was the invention built or tested? If so, the date:	
Yes	Builds 6/29/01 ? 10/25/01. Tests 10/27/01 11/25/02
Was this invention made under a government contract? If so, the agency and contract number:	
No	
<b>Description of Invention:</b> Please describe your invention in detail using the following outline.  A. Prior solutions and their disadvantages (attach copies of any pertinent product literature, technical articles, patents, etc.). B. Problems solved by the invention. C. Advantages of the invention over what has been done before. D. Description of the construction and operation of the invention. (include appropriate schematic, block & timing diagrams, drawings, samples, graphs, flowcharts, computer listings, etc.).  Electronic Attachment	
List any pertinent patents material to the invention. Electronic Attachment	
List any articles or references or devices pertinent to the invention. Electronic Attachment	
<b>Identify Inventor(s):</b> Pursuant to my (our) employment agreement, I (we) submit this disclosure on this date: 03/06/2002	

Employee No. 00490398	Name: Sam Dai	Telnet: 785-0570	Mailstop: 5651	Entity & Lab Name: BSTO 4013
Employee No.	Name:	Telnet:	Mailstop:	Entity & Lab Name:
<b>Identify Witness(es):</b> <i>(It's best to identify the person(s) to whom invention was first disclosed.)</i>				
The invention was first explained to, and understood by, the witness(es) on this date 2/28/02				
Name: Weifeng Liu	Employee No. 00588034	Telnet: 785-2106	Mailstop: 5651	Entity:
Name: Dave F. Smith	Employee No.	Telnet: 748-2181	Mailstop:	Entity:
<b>Inventor &amp; Home Address Information:</b>				
First Inventor's Full Name: Stephan Daniel Cromwell			Citizenship: USA	
Street 8380 Rock Springs Rd				
City Penryn		State CA	Zip 95663	
Do you have a Residential P.O. Address? Yes		Description POBox 6 Penryn, CA 95663		
Second Inventor's Full Name: Xiang Dia			Citizenship:	
Street 1540 Palatia Dr.				
City Roseville		State CA	Zip 95661	
Do you have a Residential P.O. Address? No		Description		
Third Inventor's Full Name:			Citizenship:	
Street				
City		State	Zip	
Do you have a Residential P.O. Address?		Description		

Hardcopy Files:



CCGA column corner shims IDF.doc

Write in Dark Ink on Front Side Only, Please



# INVENTION DISCLOSURE

PAGE ONE OF \_\_\_\_

PDNO

DATE RCVD

ATTORNEY

**Instructions:** The information contained in this document is HP Confidential and may not be disclosed to others without prior authorization. Submit this disclosure to the HP Legal Department as soon as possible. No patent protection is possible until a patent application is authorized, prepared, and submitted to the Government.

## Descriptive Title of Invention:

**Method of supporting area array solder column interconnects using corner shims between IC package and PCB**

## Name of Project:

**Concorde**

## Product Name or Number:

**Orca - Concorde**

Was a description of the invention published, or are you planning to publish? If so, the date(s) and publication(s):

**No.**

Was a product or prototype including the invention (i) announced, offered for sale, or sold to any third party (for example, customer, supplier, contract manufacturer), or (ii) sold to HP by, for example, a supplier or contract manufacturer, or (iii) is such activity proposed? If so, when and to whom?:

**No.**

Was the invention disclosed to anyone outside of HP, or will such disclosure occur? If so, the date(s) and name(s):

**No.**

*If any of the above situations will occur within 3 months, call your IP attorney or the Legal Department now at 1-898-4919 or 970-898-4919.*

Was the invention described in a lab book or other record? If so, please identify (lab book #, etc.)

**2/16/01 CCGA creep issue meeting minutes; Sam's Lab book Pages 9 (date 3/14/01), 59 (date 4/9/01); Sam's email "Concorde attach - thermal/mechanical design opportunities to enable a reliable and manufacturable CCGA solution" 6/28/01. 07/02/01 Meeting minutes on Concorde CCGA HS attach/Solder Creep. Dan's emails "Mechanical Attach Hardware Schedule" 5/18/01 "Shimmed CCGA slides" 9/25/01.**

Was the invention built or tested? If so, the date:

**Builds 6/29/01 - 10/25/01. Tests 10/27/01-1/25/02**

Was this invention made under a government contract? If so, the agency and contract number:

**No.**

**Description of Invention:** Please preserve all records of the invention and attach additional pages for the following. Each additional page should be signed and dated by the inventor(s) and witness(es).

- A. Description of the construction and operation of the invention (include appropriate schematic, block, & timing diagrams; drawings; samples; graphs; flowcharts; computer listings; test results; etc.)
- B. Advantages of the invention over what has been done before.
- C. Problems solved by the invention.
- D. Prior solutions and their disadvantages (if available, attach copies of product literature, technical articles, patents, etc.).

**Signature of Inventor(s):** Pursuant to my (our) employment agreement, I (we) submit this disclosure on this date: [ 3/1/2002 ].

Employee No.	Name	Signature	Telnet	Mailstop	Entity & Lab
372253	Dan Cromwell		748-2373	MS 5596	BSTO 5260
490398	Sam Dai		785-0570	MS 5651	BSTO 4013

(If more than four inventors, include additional information on another copy of this form and attach to this document)

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INVENTION DISCLOSURE		HP Confidential	PAGE ____ OF ____
<b>Signature of Witness(es):</b> <i>(Please try to obtain the signature of the person(s) to whom invention was first disclosed.)</i>			
The invention was first explained to, and understood by, me (us) on this date: [ _____ ]			
Full Name	Signature	Date of Signature	
Full Name	Signature	Date of Signature	
<b>Inventor &amp; Home Address Information:</b> <i>(If more than four inventors, include addl. information on a copy of this form &amp; attach to this document)</i>			
Inventor's Full Name			
<b>Xiang Dai</b>			
Street			
<b>1540 Palatia Dr.</b>			
City	State	Zip	
<b>Roseville</b>	<b>CA</b>	<b>95661</b>	
Do you have a Residential P.O. Address? P.O. BOX	City	State	Zip
Greeted as <i>(nickname, middle name, etc.)</i>		Citizenship	
<b>Sam</b>			
Inventor's Full Name			
<b>Dan Cromwell</b>			
Street			
<b>8380 Rock Springs Rd</b>			
City	State	Zip	
<b>Penryn</b>	<b>CA</b>	<b>95663</b>	
Do you have a Residential P.O. Address? P.O. BOX	City	State	Zip
<b>6</b>	<b>Penryn</b>	<b>CA</b>	<b>95663</b>
Greeted as <i>(nickname, middle name, etc.)</i>		Citizenship	
<b>Dan</b>			
Inventor's Full Name			
Street			
City	State	Zip	
Do you have a Residential P.O. Address? P.O. BOX	City	State	Zip
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Inventor's Full Name			
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Do you have a Residential P.O. Address? P.O. BOX	City	State	Zip
Greeted as <i>(nickname, middle name, etc.)</i>		Citizenship	

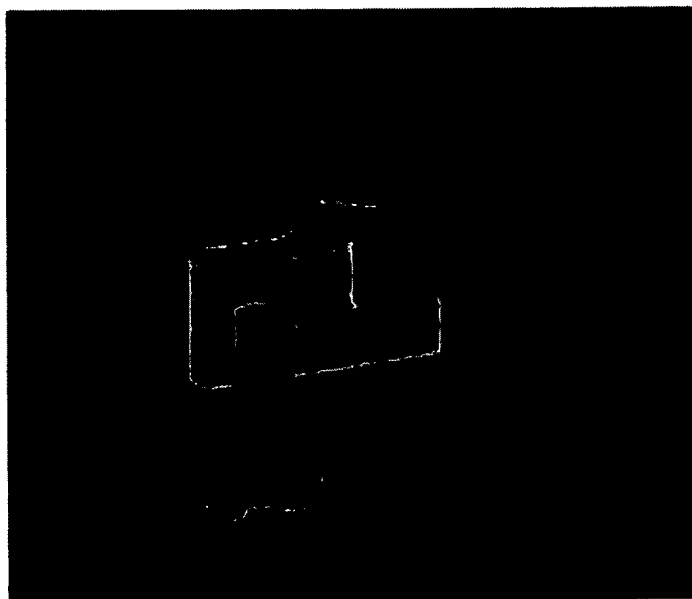
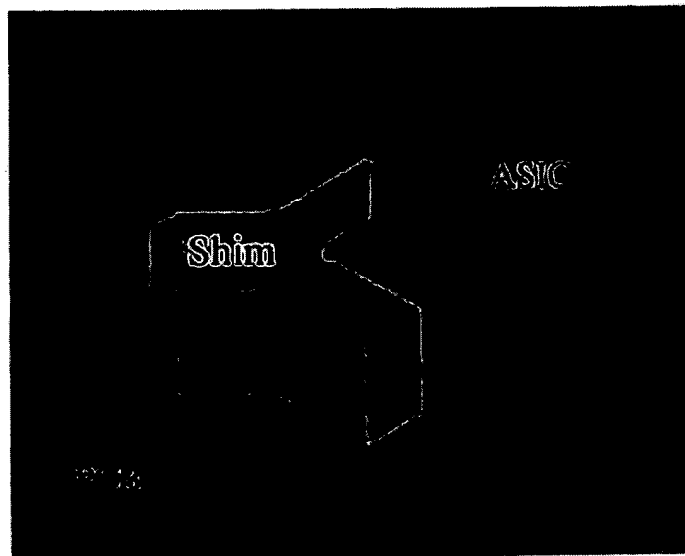
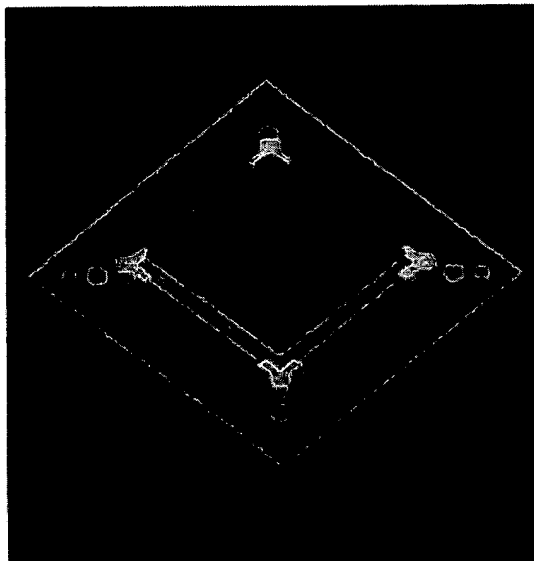


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**Description of Invention:** Please preserve all records of the invention and attach additional pages for the following. Each additional page should be signed and dated by the inventor(s) and witness(es).

- A. Description of the construction and operation of the invention (include appropriate schematic, block, & timing diagrams; drawings; samples; graphs; flowcharts; computer listings; test results; etc.).

To mechanically support the area array solder column interconnects, corner shims are inserted between the IC package and the PCB after the package is solder attached. The 4 shims are placed under the ceramic corners, which are depopulated, and rest on the PCB. Screws inserted from the underside of the PCB hold them in place. Alternately the screws can be inserted from the top as well. If the shim were plastic it could be designed with a flexible detent that could interface with a hole to retain it without hardware. The shims can be made of plastic or metal with its Coefficient of Thermal Expansion closely matched to that of the solder columns. The shim is designed so that it cannot come into contact with the columns and cause damage or shorting. (See attached drawings)



**B. Advantages of the invention over what has been done before.**

Solder column interconnects are susceptible to damage due to short-term dynamic load during shock & vibration and creep under long-term static compressive load. A thermal solution that is directly attached to the package subject the solder columns to shock & vibrate impact and thus has to be light mass to avoid excessive damage to columns. It often cannot meet the thermal requirements for large or high power packages. For large or high power packages, a high retention load is required to attach thermal solution to the package to achieve adequate thermal interface and to prevent shock and vibrate damage to the package and interconnects. This high load usually exceeds the maximum long-term compressive load that the solder columns can sustain without excessive creep, bending, and buckling causing interconnects failure such as shorting. So the solder columns have to be supported mechanically. By using the corner shims to support the solder columns, the compressive load to the solder columns are relieved once the package substrate is resting upon the shims after a slight amount of solder creep induced by the application of the retention load for the thermal solution. This invention relaxes the maximum load constraint to as high as the shim and ASIC can structurally support, thus enables a wider variety of thermal solutions for more demanding applications without compromising solder column interconnect reliability. It also relaxes the tight load tolerance constraint. Advantages over other solder column mechanical support proposals: this invention enables simple and easy assembly, consumes little PCB real estate, only needs to accommodate solder column height tolerance (less variation than column/substrate or column/substrate/heatsink stack-ups), and the shims are securely fastened without the risk of getting loose.

**C. Problems solved by the invention.**

Area array solder column interconnection is a potentially viable solution to attach large ceramic IC package to PCB because of its superior reliability over conventional ceramic ball grid array interconnection. It is also more cost effective than LGA socketed solutions. But the tall and thin solder columns are susceptible to damage due to short-term dynamic load during shock & vibration and creep under long-term static compressive load. Many of our demanding IC package applications require high retention load for large heatsink to achieve adequate thermal interface and to prevent shock and vibrate damage to the package and interconnects. The high retention load is usually higher than the maximum long-term compressive load allowed for the solder columns, typically 5-20 grams per column depending on column diameter and end-use conditions. This constraint has limited the application of the area array solder column interconnect technology. By using the corner shims to support solder column interconnects, this invention eliminates the maximum retention load constraint and enables a wide variety of thermal solution implementations without compromising reliability.

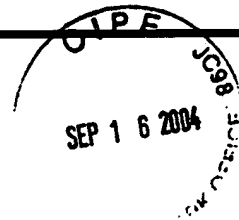
**D. Prior solutions and their disadvantages (if available, attach copies of product literature, technical articles, patents, etc.).**

IBM paper, support columns with posts attached between heatsink and PCB. Complicated and additional attach process using epoxy adhesive. Tolerance stackup hard to accommodate. HP PDNO 10015590, supporting solder columns using an external frame, additional attach process using epoxy adhesive, consume more PCB real estate. HP PDNO 10015588, using external corner supports, require custom over hang lid, additional attach process using epoxy adhesive, consume more PCB real estate. Perimeter stops, not fully fastened, risk of getting loose.

**Magoon, Sumeet**

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**From:** Ye, Michael [Ye.Michael@dorseylaw.com]  
**Sent:** Thursday, May 22, 2003 4:27 PM  
**To:** Cromwell, Dan  
**Subject:** RE: HP 100203000-1



485701-02.pdf



485703.pdf



485704.PDF



HP 100203000  
fig5.doc



HP 100203000-1  
spec.doc

Dan:

Attached please find the first draft of your patent application. Could you please review the draft and send me your comments as soon as possible? Please note that there should be no shading between the ASIC and PCB in Figs. 3a, 3b, 4a and 4b. Our draftsman is on vacation and we'll fix the figures when he comes back.

Best regards,

Michael

-----Original Message-----

From: CROMWELL, DAN (HP-Roseville,ex1) [mailto:dan.cromwell@hp.com]  
Sent: Thursday, May 15, 2003 6:07 PM  
To: 'Ye, Michael'  
Subject: RE: HP 100203000-1

Hi Michael,

Please verify that this is the version that you have.

Dan

-----Original Message-----

From: Ye, Michael [mailto:Ye.Michael@dorseylaw.com]  
Sent: Thursday, May 15, 2003 2:07 PM  
To: 'dan\_cromwell@hp.com'  
Subject: HP 100203000-1

Hi, Dan:

It was nice talking to you. I am now working on your patent application entitled "Method of supporting area array solder column interconnects using corner shims between IC package and PCB." I'll try to get the first draft to you as soon as possible. Meanwhile, could you please e-mail me the drawings that you disclosed in the Invention Disclosure? Thank you very much.

Best regards,

Michael

Michael Xuehai Ye, Ph.D.  
Patent Agent  
Dorsey & Whitney LLP  
1001 Pennsylvania Ave. NW  
Suite 400 South  
Washington DC 20004  
Tel: (202) 442-3576  
Fax: (202) 442-3199



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